



## Relationship Between Somatotype and Blood Pressure Among 30 -70 Years Old Javanese People in Sleman, Yogyakarta Province

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### KATA KUNCI KEYWORDS

*endomorfi; mesomorfi; ektomorfi; tekanan darah; lansia  
endomorphism; mesomorphism; ectomorphy; blood pressure; elderly*

### ABSTRAK

*Konsep somatotipe merupakan klasifikasi bentuk badan yang dapat dinyatakan dengan angka sederhana. Penelitian ini bertujuan untuk mengkaji hubungan antara somatotipe dengan tekanan darah pada populasi orang Jawa. Studi cross sectional dilakukan terhadap penduduk di daerah kabupaten Sleman Yogyakarta, terdiri dari 149 orang laki-laki dan 253 orang perempuan, usia antara 30-70 tahun. Subjek penelitian dibagi dalam 4 kelompok usia, yaitu 30-40, 41-50, 51-60 dan 61-70 tahun. Penentuan somatotipe menggunakan metode Heath Carter. Analisa varian digunakan untuk mengetahui perbedaan antar jenis kelamin dan antar kelompok usia. Koefisien korelasi Pearson digunakan untuk mengetahui hubungan antara tiap komponen somatotipe dengan tekanan darah. Hasil penelitian menunjukkan bahwa, kelompok perempuan secara signifikan lebih endomorfik dan kurang ektomorfik dibandingkan kelompok laki-laki. Tekanan Darah Sistolik (TDS) dan Tekanan Darah Diastolik (TDD) menunjukkan kecenderungan meningkat dengan bertambahnya usia. Pada perempuan, korelasi antara somatotipe dan tekanan darah cenderung lebih kuat pada kelompok usia 31-40 dan 41-50, sedangkan pada laki-laki pola ini kurang konsisten. Pada umumnya, ada hubungan positif antara tekanan darah dan komponen endomorfi pada kedua kelompok, sedangkan antara tekanan darah dan komponen ektomorfi cenderung negatif. Hal ini menunjukkan bahwa ponderosity dan muskularitas memiliki efek sebaliknya, namun linearitas fisik bisa menawarkan keuntungan adaptif. Penelitian lebih lanjut dibutuhkan untuk memahami mekanisme dari bentuk badan mana yang berhubungan dengan faktor risiko penyakit.*

### ABSTRACT

*The concept of somatotyping is appealing because it is a classification of total body form that can be expressed as a simple rating. The aim of this study was to determine the association between somatotype and blood pressure in Javanese people. A cross sectional study was done among the residents in Sleman district area, consisting of 149 males and 253 females, aged 30-70 years. The subjects were divided into four groups, 30-40, 41-50, 51-60, and 61-70 years of age. Somatotype was assessed using the Heath Carter anthropometric somatotype method. One-way analysis of variance was used to evaluate the statistical significance of differences between sex- and age-related groups. Pearson's correlation coefficients between each somatotype component and each blood pressure were calculated. The statistical analysis showed that females were*

*significantly more endomorphic and less ectomorphic than males. Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) showed an upward tendency with age in both sexes. The result suggests that in females, correlations between somatotype and blood pressure tended to be stronger in 31-40 and 41-50 age groups, while in males this pattern was less consistent. In general, for males and females correlation between blood pressure and endomorphy were positive, however between blood pressure and ectomorphy were negative. This suggests that ponderosity and muscularity have the opposite effect; however linearity of physique could offer an adaptive advantage. Further studies are needed in this regard to understand the mechanisms by which somatotype may be associated with risk factor for disease.*

Based on statistical data issued by the Coordinating Ministry for People's Welfare, the trend of life expectancy of people in Indonesia continues to increase from 54 in 1980 to 70 in 2008. Life expectancy is increasing when compared with life expectancy five years ago as an indicator of increasing degree of public health Indonesia. It could also mean that the old population (elderly) is growing faster than the young (youths). Elderly populations, which generally have high levels of physical inability associated with higher chronic diseases, with life expectancy increasing, of course, requires great care, so it will burden the healthcare system over the state.

Hypertension is a common condition among older people and an important risk factor for all types of vascular disease. Hypertension or high blood pressure is a medical condition in which an increase in blood pressure is chronic (long-term). Patients who had at least three blood pressure readings exceeding 140/90 mmHg at rest are expected to have high blood pressure condition. High blood pressure is a risk factor for stroke, heart attack, heart failure and arterial aneurysm, and is a major cause of chronic heart failure.

Based on WHO data, hypertension causes one of the eight deaths that occur worldwide. In the late 20th century, the heart and blood vessel diseases were leading cause

of death in developed and developing countries. Most people with hypertension in Indonesia are not detected, while those detected are generally not aware of the disorder. The results of the analysis of Research and Development in 2009 found that the prevalence of hypertension in Indonesia in 2007 was 32.2%, the highest prevalence was found 39.6% in South Kalimantan Province, and the lowest was found in West Papua, 20.1% (Rahajeng, 2009).

Somatotyping is the most recent development in the twenty-five century history of morphological taxonomy and constitutional investigation. Tucker & Lessa (1940) *cit.* Carter & Heath (1990) in their review of the history of human classification defined constitution as the sum total of morphological, physiological and psychophysical characters of an individual. Somatotype was defined as representing the individual's "present morphological conformation", in practice, the Heath Carter method of somatotyping is used primarily in its anthropometric form (Malina *et al.*, 2004). Somatotyping uses three components of body shape, while classification based on factor analysis reduces a set of variables into a small

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number of factors, and is expressed by a 3 number rating that represents the components of endomorphy (fatness), mesomorphy (musculoskeletal development) and ectomorphy / linearity (Susanne *et al.*, 1998; Carter & Heath, 1990).

The relationship between somatotype and disease has been first investigated by Sheldon *et al.* (1969) *cit.* Singh (2007) in their study on psychotic patterns with somatotype. Some studies show relationship between somatotype components and diseases, i.e. blood pressure (William *et al.*, 2000, Badenhorst *et al.*, 2003, Herrera *et al.*, 2004, Kalichman *et al.*, 2004, Malina *et al.*, 1997, and Makgae *et al.*, 2007), diabetes mellitus (Buffa *et al.*, 2007, Vikram *et al.*, 2007 and Yadav *et al.*, 2007), cardiovascular (Malina *et al.*, 1997), metabolic fitness (Katzmarzyk *et al.*, 1998), and chronic diseases (Koleva *et al.*, 2002). Herrera *et al.* (2004) observed the correlation between ectomorphy and both Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP). It was shown that as ectomorphy increased the blood pressure decreased, except for oldest age group. Malina *et al.* (1997) investigated 642 apparently healthy adults particularly on blood pressure (SBP and DBP), fasting glycaemia and blood fats. The results showed that the correlation ranged from - 0.20 to + 0.30 in women, and - 0.23 to + 0.23 in males. Groups with older age had a stronger correlation, in women with high total skinfold thickness showed a positive correlation with risk factors, whereas in males showed a negative correlation. Kalichman *et al.* (2004) observed that individuals of robust physique (with high endomorphy and mesomorphy) showed high mean values of SBP and DBP, whereas the smallest persons had the lowest BP values. According to Badenhorst *et al.* (2003), somatotype and elevated blood pressure showed correlation which indicated that the blood pressure of the endomorphic boys was

the highest which increased with in physical activity levels.

Epidemiological data reveals the importance of blood pressure and pulse as risk factors for coronary disease, even in the range of high-normal blood pressure. Research on somatotype in relation to blood pressure in older age groups is very important to do especially in the field of clinical epidemiology and geriatrics, thus achieving a better understanding of morphological and physiological changes that occur during aging. With early detection of hypertension, the incidence and risk factors for cardiovascular disease will be reduced.

## MATERIALS AND METHODS

These cross sectional study was conducted on 402 people (149 males and 253 females) recruited from Sleman district area, aged 30 - 70 years old. The subjects were subdivided into five age groups i.e. 20-30 years, 31-40 years, 41-50 years, 51-60 years and 61-70 years. Both the somatotype and blood pressure data were collected during measurements in July to August 2011. For blood pressure, each subject was examined by a physician, and somatotype measurement was performed by an anthropometry expert. Subjects were given written informed consent to participate in the study, which was approved by the Medical Ethics Committee at Gadjah Mada University.

Specially designed questionnaires were used to obtain information from participating subjects about their sex, date of birth, medical history, education, occupation, and income status.

### Somatotype

The following 10 measurements, as required for Heath-Carter somatotyping were obtained during the morning hours as far as possible including stature, weight, and triceps

skinfold, subscapular skinfold, suprailiac skinfold, medial calf skinfold, biepicondylar breadth of the humerus, and biepicondylar breadth of the femur, upper arm girth and calf girth.

The three somatotype components, i.e. endomorphy, mesomorphy, and ectomorphy, of each individual were calculated according to the Heath-Carter method using the following equations (Carter & Heath, 1990):

$$\text{Endomorphy} = -0.7182 + 0.1451(X) - 0.00068(X^2) + 0.0000014(X^3)$$

where X = sum of triceps, subscapular and supraspinale skinfold. For stature-corrected endomorphy, multiply X by 170.18/stature in cm.

$$\text{Mesomorphy} = [(0.858 \times \text{humerus breadth}) + (0.601 \times \text{femur breadth}) + (0.188 \times \text{corrected arm girth}) + (0.161 \times \text{corrected calf girth})] - (\text{height} \times 0.131) + 4.5$$

$$\text{Ectomorphy} = \text{HWR} \times 0.732 - 28.58$$

If HWR is less than 40.75 but more than 38.25, Ectomorphy =  $\text{HWR} \times 0.463 - 17.63$ .

If HWR is equal to or less than 38.25 give a rating of 0.1

$$\text{HWR} = \text{stature} / \text{cube root of weight}$$

The mean somatotype of each age group was plotted on a somatochart after calculating X and Y coordinates according to the following formula (Carter & Heath, 1990) using the mean score of each somatotype component:

$$X \text{ coordinate} = \text{ectomorphy} - \text{endomorphy}$$

$$Y \text{ coordinate} = 2 \times \text{mesomorphy} - (\text{endomorphy} + \text{ectomorphy})$$

### Blood Pressure

Blood pressure was measured in the right arm supported on a table at heart level with the subject seated. Two consecutive readings of SBP and DBP were taken with a sphygmomanometer and stethoscope after 3-

min rest period, with the subject in a supine position. SBP was taken as the onset and DBP as the cessation of Korotkoff sounds.

### Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences 17 (SPSS). The difference between sex and age-related groups was tested by a one-way analysis of variance, whereas association between each somatotype components and each blood pressure were identified using Pearson's correlation coefficients.

## RESULTS

Sample size and descriptive statistic for age, somatotype and blood pressure by age group and sex are presented in Table 1. Correlation coefficients for somatotype components and blood pressure by age group and sex are presented in Table 2.

The mean somatotype of males in total was 3.9 - 4.7 - 2.0 or endomorphic mesomorph (SD: 1.5 - 1.4 - 1.3) and 6.4 - 4.8 - 1.0 or mesomorphic endomorph (SD: 1.5 - 1.7 - 1.1) in females. Figure 1 and 2 present the mean values of SBP and DBP in males and females aged 30-70 years. Figure 3, 4, and 5 present the mean of somatotype components for each age and sex groups. The mean somatotypes for males of all ages are less endomorphic and more ectomorphic than females ( $p < 0.001$ ). For somatochart, in males, the somatopoints fell in endomorphic mesomorph, while in females; the somatopoints fell in mesomorphic endomorph (Figure 6). In each group, females of all ages are significantly more endomorphic (relative adiposity) and less ectomorphic than males ( $p < 0.001$ ). Additionally, 61-70 year old females are not significantly less ectomorphic than males.

There are no sex differences in blood pressure in this sample. SBP and DBP

exhibited an upward tendency with age in both males and females. In both cases, the

highest values were found in the 61-70 age groups (Figure 1 and 2).

Table 1. Descriptive statistics of somatotype components by age and sex in Javanese Population

Age groups	n	Endomorphy		Mesomorphy		Ectomorphy		SBP,mm/Hg		DBP,mm/Hg	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Males											
30-40	22	4.5***	1.5	4.4	1.8	1.7**	1.1	115.9	11.2	77.5	7.2
41-50	55	3.8***	1.4	4.6	1.3	2.0***	1.2	120.9	12.8	79.4	8.0
51-60	58	3.8***	1.6	4.6	1.3	2.2***	1.5	125.9	20.3	81.2	11.0
61-70	14	3.9**	1.0	5.3	1.1	1.7	1.1	139.9	22.3	85.7	10.2
Total	149	3.9***	1.5	4.7	1.4	2.0***	1.3	124.1	17.8	80.5	9.5
Females											
30-40	50	6.4***	1.4	4.4	1.7	1.0**	1.0	118.7	16.4	78.8	9.6
41-50	107	6.7***	1.4	4.8	1.5	0.8***	1.0	121.2	18.7	79.4	12.1
51-60	71	6.3***	1.6	5.0	1.7	1.1***	1.4	129.0	22.3	83.0	19.9
61-70	15	5.8**	1.7	5.4	1.7	1.1	1.1	134.7**	18.1	84.3	7.3
Total	253	6.4***	1.5	4.8	1.7	1.0***	1.1	124.4	20.3	80.8	11.2

Statistically significant differences: \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$   
SBP (systolic blood pressure), DBP (diastolic blood pressure)

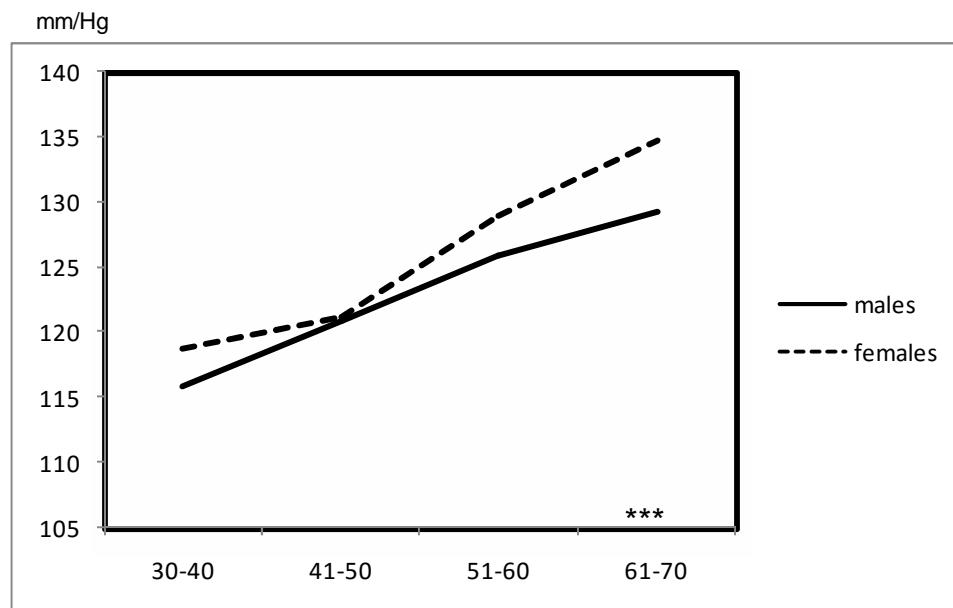


Figure 1. The mean value of SBP (systolic blood pressure) in males and females aged 30-70 years (\*\*\* $p < 0.001$ ).

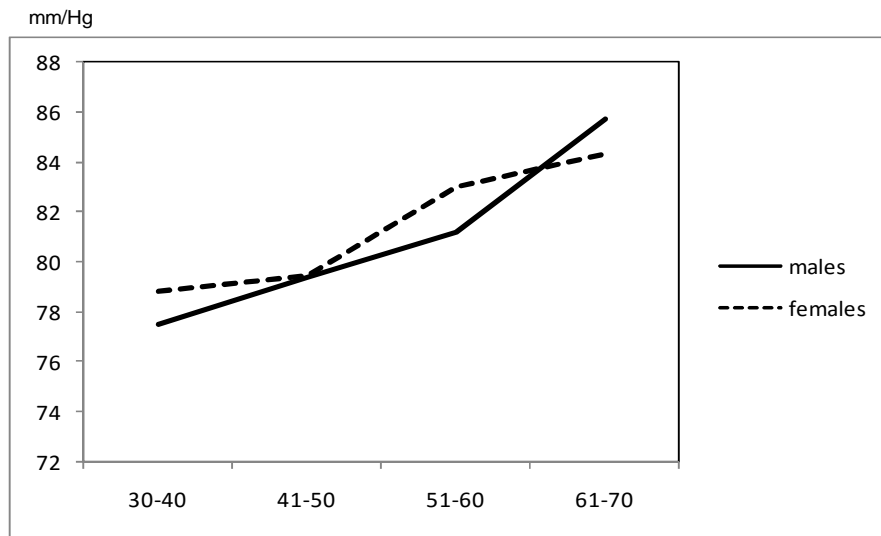


Figure 2. The mean value of DBP (diastolic blood pressure) in males and females aged 30-70 years

For endomorphy (Figure 3), in males, the maximum mean value (4.5) was noted in age group of 30 - 40 years and the minimum (3.8) in age groups of 41 - 50 and 51 - 60 years. In contrast, the maximum mean value for this trait (6.7) in females was noted in age group of 41 - 50 years and the minimum (5.8) was in age group of 61 - 70 years. In term of mesomorphy (Figure 4), the maximum mean value in both males and females were at the age of 61-70 years (5.3 in males and 5.4 in females), while the minimum mean value were in the age group of 30-40 years with the same value 4.4. On the other hand, as for ectomorphy (Figure 5), males have the maximum mean value (2.2) in age group of 51 - 60 years and the minimum mean value (1.7) in age groups of 30 - 40 and 61 - 70 years, whereas in females, the maximum mean value (1.1) in age groups of 51 - 60 and 61 - 70 years, and the minimum mean value (0.8) in age group of 41 - 50 years. When all age groups were pooled, highly significant differences ( $p < 0.001$ ) were noted in endomorphy and ectomorphy between males and females (Tabel 1).

Based upon the mean values of each component score presented in Table 1, we

determined the X and Y coordinates in order to plot the mean somatotype on the Carter's somatochart (Figure 6).

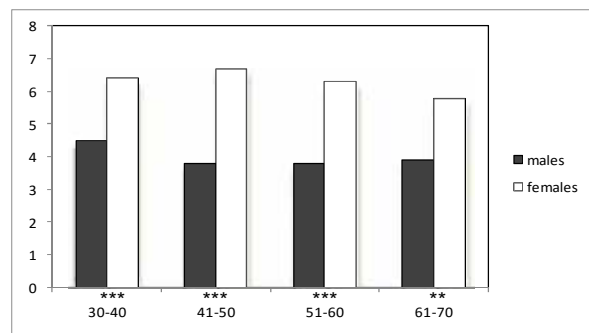


Figure 3. The mean score of endomorphy in males and females aged 30-70 years

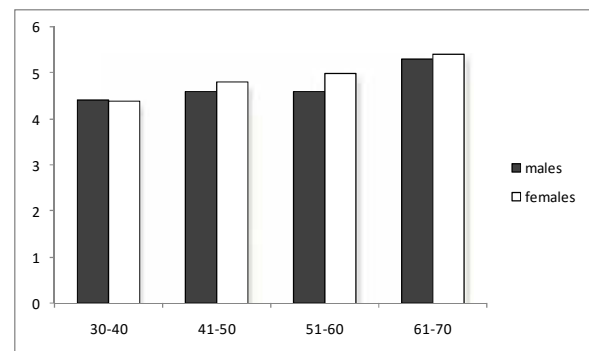


Figure 4. The mean score of mesomorphy in males and females aged 30-70 years

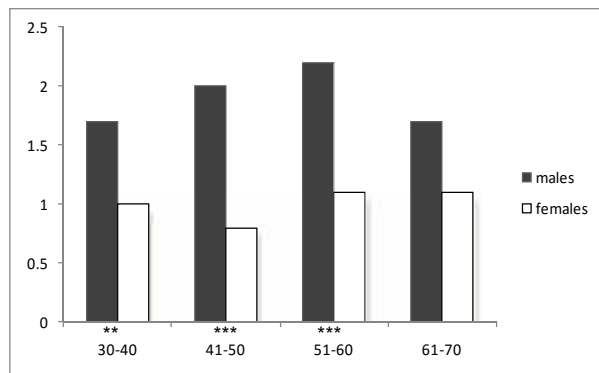


Figure 5. The mean score of ectomorphy in males and females aged 30-70 years

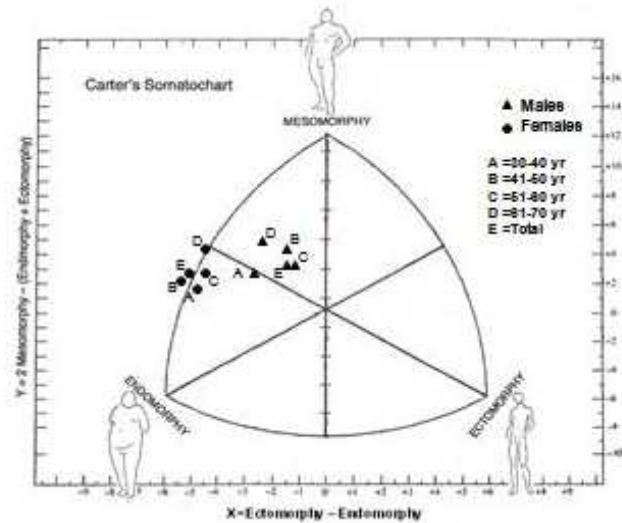


Figure 6. Mean somatotype of the Javanese people in Sleman district by age groups

Table 2. Correlation coefficients for blood pressure and somatotype components in Javanese people

Age groups	Systolic blood pressure			Diastolic blood pressure		
	Endo	Mesc	Ecto	Endo	Mesc	Ecto
Males (n=149)						
30-40	0.18	0.41	-0.26	0.29	0.38	-0.35
41-50	0.21	-0.09	-0.32**	0.35**	-0.04	-0.40**
51-60	0.18	-0.09	-0.19	0.20	-0.05	-0.24*
61-70	0.24	0.29	-0.49*	0.41	0.16	-0.47*
Total	0.15*	0.09	0.26**	0.24**	0.09	-0.31**
Females (n=253)						
30-40	0.24*	0.35**	-0.29*	0.31*	0.34**	-0.27*
41-50	0.19*	0.26**	-0.24**	0.15	0.23**	-0.18*
51-60	0.04	0.10	-0.15	0.09	0.09	-0.17
61-70	0.31	-0.05	-0.08	0.28	0.14	-0.20
Total	0.12*	0.25**	-0.19**	0.15**	0.23**	-0.18**

Statistically significant correlations: \* $p < 0.05$ ; \*\* $p < 0.01$

In Table 2 correlation coefficients ranged from -0.49 to +0.41 in males, and from -0.29 to +0.35 in females. Among 41- to 50-year-old males, one positive and two negative correlation between somatotype components and blood pressure were found to be statistically significant ( $p < 0.01$ ). Within the 51-60 and 61-70 year age groups, only negative correlation between ectomorphy and blood

pressure were statistically significant ( $p < 0.05$ ). On the other hand, in males, association of somatotype components (endomorphy and ectomorphy) with blood pressure (SBP and DBP) significant correlation ( $p < 0.01$ ), was observed while in 30-40 age group no correlation was found to be statistically significant.

In females, SBP and DBP were positively and significantly correlated with endomorphy, mesomorphy and ectomorphy in the 31-40, 41-50, and total sample groups. For the 51-60 and 61-70 age groups, no correlation was found to be statistically significant.

## DISCUSSION

In the present cross-sectional study, associations between somatotype and blood pressure during ageing in the Javanese people at Sleman, Yogyakarta province were studied. Previous studies (Badenhorst *et al.*, 2003; Herrera *et al.*, 2004; Kalichman *et al.*, 2004; Williams *et al.*, 2000) found that somatotype, as a description of the present morphological conformation, was associated with the blood pressure. This present study also found association between somatotype and blood pressure.

The results indicate a weak to moderate association between somatotype and blood pressure in people of 30-70 years old. Subjects with a physique characterized by high endomorphy and mesomorphy, and low ectomorphy are more likely to have a poor blood pressure with a high value for SBP. These findings are consistent with those reported by Herrera *et al.* (2004) that among males and females of 60-125 years in Caracas, Venezuela, those with high blood pressure tend to be more endomorphic and mesomorphic and less ectomorphic. Kalichman *et al.* (2004) observed that individuals of robust physique (with high endomorphy and mesomorphy) showed high mean values of systolic and diastolic BP, whereas the smallest persons had the lowest BP values. Moreover, Kalichman *et al.* (2004) suggested that the existence of common physiological paths in the development of body physique and blood pressure regulation may possibly be indicative of the involvement of pleiotropic

genetic and/or epigenetic mechanisms in this regulation. Carter & Heath (1990) also suggested that individuals with somatotypes high in ectomorphy and low in endomorphy but high in mesomorphy, are rarely found in distributions of coronary heart disease patients.

Research by Badenhorst *et al.* (2003) on boys South Africa aged 10-15 years showed that the blood pressure of the endomorphic boys was the highest which increased with an increase in physical activity levels, and an increase in physical activity did not lower the resting blood pressure values of endomorphic boys. Longitudinal study conducted by Harlan *et al.* (1962, *cit.* Singh, 2007) found that subjects with a predominance of ectomorphic characteristics had a smaller increment of blood pressure. A significantly greater increase in blood pressure was acknowledged to be a predisposition factor because of family history in these subjects.

For risk factor, the association was more apparent in females than in males (Table 2), and more so in those 30-40 years than those 41-50 in females, and in those 41-50 in males. These results do not correspond to Malina *et al.* (1997) in 642 healthy adults, which stated that endomorphy which represented relative fatness tended to be positively related to risk factors in older females, however for males, the result is consistent to Malina *et al.* (1997) that ectomorphy or relative linearity tended to be negatively related to risk factors in older males. Moreover, Malina *et al.* (1997) suggested that persons with higher risk profile tended to be more endomorphic and mesomorphic and less ectomorphic than those with a lower risk profile. Similar results were also obtained by Herrera *et al.* (2004) that the persons with high levels of SBP and DBP had mean somatotypes, which were closer to be characterized by myocardial



infarct, coronary heart disease and the risk of hypertension, indicating that these somatotypes may be associated with cardiovascular risk factor.

The individual who had cardiovascular risk profile are more endomorphic and mesomorphic and less ectomorphic than those with a lower cardiovascular risk factor. In our study, correlation analysis indicated that relationship were stronger in groups under 51 years of age, than in older adults, but the association pattern varied depending on sex.

Williams *et al.* (2000) suggested that in case of patients of coronary artery disease (CAD), endomorphy was significantly correlated with abdominal circumference, the abdomen-to-hip ratio and the abdominal sagittal diameter, while Katzmarzyk *et al.* (1998) found that the somatotype has been related to sum of six skinfolds taken at different sites. That's understandable because the determination of endomorphy component using 3 skinfolds.

Figure 4, 5, and 6 showed that a relative predominance of endomorphy and mesomorphy was observed in females, while males were predominant in ectomorphy, which finding are consistent with those reported by some authors (Malina *et al.* 2004; Herrera *et al.* 2004). This condition may suggest that an overestimation of mesomorphy may exist in female elders, in whom redistribution of body fat could affect the calculation of this component. Some authors also pointed out that redistribution of body fat moves from the periphery towards the trunk with age. This fat mobilization could cause an error in the discrimination of fat surrounds muscle and bone, since part of this fat may have been considered as muscularity (Herrera *et al.* 2004; Wilmore, 2005).

Based upon the Figure 6, we note here that mean somatotypes of males in all ages

were 3.7 - 4.9 - 2.0, thus falling within the category of endomorphic mesomorph, while those for females were 6.4 - 4.8 - 1.0, thus falling into mesomorphic endomorph category. When compared with mean somatotype of hypertension males (4.3 - 4.7 - 2.1) by Herrera *et al.* (2004), the Javanese males were less endomorphic; whereas the Javanese females were more endomorphic and less mesomorphic than hypertension females (5.3 - 5.4 - 1.2). However, for the somatotype distribution on somatochart, the present study showed similar somatotype pathways with the Herrera research.

In general, in male and female groups correlation between blood pressure and endomorphy were positive, however between blood pressure and ectomorphy were negative. Among females, there was a positive association between blood pressure and mesomorphy. This suggests that ponderosity and muscularity have the opposite effect in female; however linearity of physique could offer an adaptive advantage among both sexes.

## CONCLUSION

It may be concluded that females are significantly more endomorphic (relative adiposity) and less ectomorphic than males. There are relationship between somatotype and blood pressure, and in general for both sexes, correlation between blood pressure and endomorphy were positive, however between blood pressure and ectomorphy were negative. This suggests that ponderosity and muscularity have the opposite effect; despite linearity of physique could offer an adaptive advantage. More research are needed in this regard to understand the mechanisms by which somatotype may be associated with risk factor for disease.

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